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The role of fire in plant conservation in wheatbelt remnants

Vegetation monitoring and management at Kinglake National Park following the 2009 Black Saturday Bushfires

Integrating fire management into conservation actions for the threatened shrub *Grevillea caleyi*

Translating science into practice for improved fire management and biodiversity conservation in South East Queensland

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SPECIAL THEME: FIRE AND THREATENED BIODIVERSITY

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Australasian Plant Conservation is a forum for information exchange for all those involved in plant conservation: please use it to share your work with others. Articles, information snippets, details of new publications or research, and diary dates are welcome. **The deadline for the September–November 2013 issue is Friday 12 August 2013.** The theme for the issue will be *Value of plant conservation to animals*. General articles are also very welcome. Please contact Selga Harrington if you are intending to submit an article: selga.harrington@gmail.com

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Correction: The following photos were taken by Andrew Crawford:

- photo of Endangered *Verticordia* seed in safe hands, on cover of APC 21(4) and on page 22
- Photo of Bree Phillips, DEC Conservation Officer, collecting seeds of the threatened *Jacksonia velveta*, provided on page 23.

Front cover: Fruit of *Hakea pandanicarpa*, opened after the plant was killed by fire. Photo: Carl Gosper and Georg Wiehl

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From the editor

Selga Harrington
Parsons Brinckerhoff

Welcome to the winter edition of *Australasian Plant Conservation*! The theme for this edition is Fire and threatened biodiversity.

Fire is a common disturbance in Australia and has shaped the landscape, habitats, survival of animals and patterns of vegetation. Fire can produce dramatic changes in the environment and following fire, plants can experience increases in space, light, water, pH and total soluble salts. Plants utilise these improved conditions after fire in a variety of ways. In some species fire stimulates flowering or seed release. Other species with seed accumulated in the seed bank use specialised cues to synchronise germination to the post-fire environment. These germination cues may be either physical (such as heat shock cracking impermeable seed coats) or chemical cues (such as leachates of wood, smoke and ash).

The germinability of seeds varies with age with seeds usually exhibiting a decline in germinability with increasing age. Due to these changes in seed viability, species dependant on fire for germination or seed release can disappear from the environment if the fire interval is too long. Short fire intervals can also result in loss or decline of fire sensitive species if there is insufficient time between fires for plants to reach reproductive maturity.

Fire is a major tool available for land management and can be used to protect property from wildfire, protect fire sensitive habitats, maximise biodiversity and manage woody weeds. Although fire is an important management tool, there are many gaps in our knowledge of how and how often it can and should be used. In this edition we explore the use of fire for plant conservation, in particular for management of threatened ecological communities, threatened species and their habitats.

The edition also includes an article on the new IUCN Red List of threatened communities and concludes with the regular features: Report from New Zealand Plant Conservation Network, Recent workshop reports, Upcoming conferences, Information resources and useful Websites and finally the Research roundup.

A hot topic for the cooler winter months. Happy reading!

Integrating fire management into conservation actions for the threatened shrub *Grevillea caleyi*

Tony D. Auld and Judith Scott*

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Managing threatened species in fire-prone habitats requires an understanding of how fire, in combination with other existing threats, impacts on these species. In urban areas, there is also the priority issue to manage fire for the protection of life and property. Successful integration of these issues into an effective recovery program for a threatened species is the goal of conservation management.

Grevillea caleyi, an endangered shrub

The shrub *Grevillea caleyi* is listed as endangered under both the NSW *Threatened Species Conservation Act* in NSW and the Commonwealth *Environment Protection*

Grevillea caleyi in flower. Photo: Mark Ooi *and Biodiversity Conservation Act*. It is confined to an area of some 8 x 8 km in northern Sydney (Scott *et al*. 1995, DEC 2004). The species is known from floristically diverse remnant patches of bushland on three Hawkesbury sandstone ridgetops with laterite cappings. These ridgetops have been developed for housing, rural properties and roads and infrastructure so that over 85% of the habitat of the species has been lost (Scott *et al*. 1995). A few patches of *G. caleyi* remain on the edges of Garigal and Ku-ring-gai Chase National Parks. Ongoing threats include weeds, further loss of habitat to housing, infrastructure and road widening.

Consequently, the remaining habitat of *G. caleyi* is divided into two main types in relation to fire management. Firstly, many *G. caleyi* remnant sites are burnt in large expansive wildfires that occur approximately every 15-20 years (the last major fires being 1979 and 1994). These sites may also be subject to ongoing hazard reduction burning. Some sites are now isolated from the surrounding expansive bushland and generally do not burn in large wildfires. These sites may not experience fires for >30 years and fire needs to be actively applied to such sites to promote the conservation of *G. caleyi*.

Fire regime impacts

To manage fire in conservation planning for both *G. caleyi* and its surrounding habitat (the Duffys Forest Ecological Community, which is listed on the NSW *TSC Act* as endangered), the potential impact of each component of the fire regime has been considered in fire management guidelines (DEC 2004). These guidelines drew upon existing relevant literature on how fire impacts on *G. caleyi* and other species with similar life histories.

Fire frequency

Fire frequency thresholds are important as *G. caleyi* plants are killed by fire and rely on germination from a soil-stored seed bank for post-fire recruitment (Auld and Scott 2004). The species mostly occurs in areas managed to reduce fuel for the protection of life and property, so there is an ongoing need to conduct hazard reduction burning to reduce fuel loads in habitat of *G. caleyi*. The guidelines for fire frequency suggest a fire-free threshold of 8-12 years to allow sufficient time for seedlings to mature (2-4+ years), grow and replenish the soil seed bank. It is essential to prevent any site from being burnt by three consecutive fires at <5 year intervals. Auld and Scott (2004) showed declines in abundance of 46% and 55% from two sites that had been burnt twice in 5 years. At the same time, any areas >20 years since fire, and degraded by invasion of exotics or non local native species, may require a fire to promote the recovery of *G. caleyi* and its habitat (DEC 2004). These fire frequency thresholds are used in the annual fire planning process to determine if any site containing *G. caleyi* should be burnt for fuel reduction purposes as well as being incorporated into the statutory fire planning document for environmental assessment in NSW (the NSW Rural Fire Service Bushfire Code). There still remains a risk that wildfires may burn over any areas burnt in hazard reduction burns, so even this protection may lead to the unforseen risk of increases in fire frequency. But the risk from having too frequent fire from hazard reduction burning is greatly reduced.

Top: Burning in and around habitat of Grevillea caleyi. *Bottom: Seedlings of* Grevillea caleyi *emerging soon after a fire. Photos: Tony Auld.*

Fire spatial extent

For other components of the fire regime, research on impacts and thresholds are not yet complete, so the guidelines are more precautionary. Fires of small spatial extent are not recommended for *G. caleyi* sites where there is widespread adjacent vegetation that remains unburnt.

Post-fire grazing impacts on seedlings can be high in such spatially small fires, and there is also a high risk of increased fire frequency from a fire burning across the site from the adjacent unburnt vegetation.

Fire severity

Whilst seedling recruitment is known to be very high after severe wildfires (high loss of organic matter) (Auld and Scott 2004), recruitment may be variable after lower severity fires, such as hazard reduction burns. For example, a site burnt in the January 1994 wildfire had over 3000 seedlings emerge post-fire. The same site burnt in a hazard reduction burn 15 years later only produced 500 seedlings, while all adults were killed. Many factors may influence the magnitude of seedling recruitment, including fire cues and post fire rainfall. There is some data on *Grevillea* (and *G. caleyi*) that suggest that heat and smoke in combination may be a promoter of germination (Kenny 2000, Llorens 2004). Consequently the guidelines (DEC 2004) suggest that whilst the effect of fire severity is largely unknown, fires of varying severities are recommended to try and promote seedling recruitment.

Fire season

There is no evidence that *G. caleyi* and its associated habitat has any major requirements for burning in any particular season. Sydney can have significant rainfall that promotes seed germination at any time of the year. Consequently, no advice on the preference for fire in different seasons can be made at present, but repeated fires in only one season should be avoided.

Conclusion

Integrating the fire management recommendations for *G. caleyi* into the existing annual fire planning process along with actions to reduce the impacts of threats to the species (for example weed control and fire have been used as combined tools to promote recovery in long unburnt sites) has led to a pathway to promote evidence-based conservation management. The fire management guidelines for *G. caleyi* are designed to be dynamic and to be updated as new research becomes available, and offer a long term solution for conserving a fire-sensitive threatened plant. Monitoring the success of the program can be done by fire mapping and recording fire history in combination with on ground estimates of seedling population sizes after each fire.

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Translating science into practice for improved fire management and biodiversity conservation in South East Queensland

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The South East Queensland Fire and Biodiversity Consortium (SEQFBC) was established in 1998 and is a network of land managers and stakeholders aimed at providing a coordinated response and best-practice recommendations for fire management, fire ecology and biodiversity conservation in South East Queensland (SEQ) through education, community engagement, applied research and representation.

The key aims of the SEQFBC are:

- Education and engagement - assisting land managers and private land holders with practical information on fire management and biodiversity conservation
- Applied research - fire ecology research investigating knowledge gaps in biodiversity and fire management

- Representation and response - provision of coordinated responses to matters of significant fire management and fire ecology importance (e.g. legislative amendments and government inquires).

The SEQFBC is currently hosted by SEQ Catchments, the Natural Resource Management body for SEQ and is generously supported by: all of the SEQ local governments; Powerlink Queensland; Queensland Fire and Rescue Service; the Department of National Parks, Recreation, Sport and Racing; and SEQ Catchments. This partnership provides excellent opportunities for ongoing engagement with private landholders, public land managers and universities.

The SEQFBC currently employs two part time officers (working a total of six days per week) and is assisted by a group of enthusiastic volunteers on the Steering Committee, Education and Research Working Groups.

Education and engagement

The SEQFBC assists public land managers and private land owners with practical information on fire management and biodiversity conservation via workshops, talks, forums, training, newsletters and provision of education materials. A regular compilation of news, notification of research papers and all things relating to fire and biodiversity is sent via the popular SEQFBC e-news.

The SEQFBC website (www.fireandbiodiversity.org.au) provides access to SEQFBC fact sheets, e.g. protected vegetation and fire management (the fact sheet series is currently under review). Comprehensive manuals are also available for free download on the website, including the *Fire and Biodiversity Monitoring Manual, Fire Management Operational Manual* and *Individual Property Fire Management Planning Kit* (currently under review an updated version will be released this year). The revision of SEQFBC education material is overseen by the Education Working Group (EWG). The EWG is made up of the SEQFBC Manager and Coordinator and nine volunteers from six organisations and meets three-four times a year to review and contribute to work within the SEQFBC education aim.

The most popular SEQFBC service is the one day Individual Property Fire Management Planning Workshops. In the 2011/2012 financial year, SEQFBC delivered 13 workshops for seven councils, attracting over 260 participants. The workshop is aimed at private landowners. Participants are led through the development of a fire management plan and provided with relevant property level mapping. Participants meet their local Rural Fire Service (RFS), local government and Queensland Parks and Wildlife Service (QPWS) officers, building invaluable relationships. An amended version of this workshop is also provided to local governments, whereby officers gain a greater appreciation and understanding of the appropriate use of fire in the landscape.

The biannual SEQFBC forums are extremely popular and frequently attract over 100 attendees. Forums are held in venues around SEQ and generally focus on providing a range of speakers on fire ecology research, fire management projects (from both public and private land), fire policy and legislation changes/updates and provide an efficient means of informing the membership of current work priorities and projects. The most recent forum was an enormous success, held on 1 May at Beewah Community Hall (Sunshine Coast) and the theme was "*Linking Traditional Owner and Western Fire Management*". The forum was generously sponsored by Sunshine Coast Regional Council, attracted over 90 attendees and featured Gubbi Gubbi Elder, Nurdon Serico, the Bunya Murri Rangers and the NSW Nature Conservation Council Firesticks project.

The SEQFBC also provides essential training opportunities for member organisations. Recent training includes the popular Fuel Hazard Assessment one day workshop and fire weather training. The understanding of fuels and fire weather are very important tools for land managers and these training sessions are often oversubscribed.

Recipient of the 2011/2012 South East Queensland Fire and Biodiversity Consortium Student Research Grant, Diana Virkki of Griffith University. Photo Courtesy of Diana Virkki. Photographer: Amanda Dawson

Queensland Parks and Wildlife Service Staff undertaking a hazard reduction burn along a roadside at Samford (August 2012). Photo: D. Gilmour

Applied research

A key function of the SEQFBC is to participate and collaborate with researchers both in SEQ and across Australia. A primary way in which this is done is through the coordination of the SEQFBC Research Working Group (RWG). The RWG meets twice a year and is made up of the SEQFBC Manager and Coordinator and 24 volunteers from 17 organisations. The RWG provides land managers, researchers, students and academics with up to date information on fire ecology research and provides a forum to meet and share information and collaborate on projects. The RWG also assists in the production and review of relevant SEQFBC publications (e.g. fact sheets) and will be contributing to the new SEQFBC Fire Research newsletter, due out later this year.

The SEQFBC provides an annual Research Student Grant that aims to assist Honours or PhD students in undertaking vital fire ecology research within the SEQ region. This program began in the 2011/2012 financial year and was awarded to Diana Virkki from Griffith University, who is studying the relationship between fire mosaics and reptile communities in southeast Queensland.

Currently, the SEQFBC, in partnership with the NSW Nature Conservation Council (lead agency) and SEQ Catchments, is undertaking an on-ground project focussed on protecting threatened species habitat in the Border Ranges through the implementation of fire infrastructure, weed management and improved fire management. The project is working with landholders in the region to improve habitat for the endangered Eastern Bristle Bird (*Dasyornis brachypterus*), Hastings River Mouse (*Pseudomys oralis*) and Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*). Funding was successfully sought via Caring for our Country and is near completion. Further information on this project can be found in the article on the Northern Rivers Fire and Biodiversity Consortium.

Representation and response

The SEQFBC provides a coordinated response to matters of regional, state and national fire management and fire ecology importance. As such, in the past year the SEQFBC have provided formal submissions to the Queensland RFS review, the *Environmental Protection and Biodiversity Conservation Act 1999* nomination to list the Noisy Miner as a key threatening process for other native woodland birds and the review of the State Planning Policy (SPP 1/03) on *Mitigating the Adverse Impacts of Flood, Bushfire and Landslide.*

In 2012, in response to community concern and lack of an identified process, SEQ Catchments asked the SEQFBC to manage a project on the issue of fuel load management on roadside reserves. The aim was to identify a process by which landholders could apply to undertake hazard reduction burns on land adjoining their property, without prohibitive costs, insurance or biodiversity risk. After extensive consultation with stakeholders two models where identified:

- the South Burnett Regional Council Model (whereby landholders apply to conduct roadside burns whilst covered by council insurance)
- the Coordinated Agency Model (comprising a cooperative approach from Toowoomba Regional Council, Queensland Fire and Rescue Service, Department of Transport and Main Roads and QPWS).

The SEQFBC concluded that the Coordinated Agency Model offered the greatest potential for addressing the issue whilst minimising insurance risk. The project has been a great success and one council is currently finalising arrangements for the implementation of the Coordinated Agency Model in its area.

For further information please visit the SEQFBC website: www.fireandbiodiversity.org.au

Ecologically sustainable fire management for the Northern Rivers region of NSW

Greg Banks

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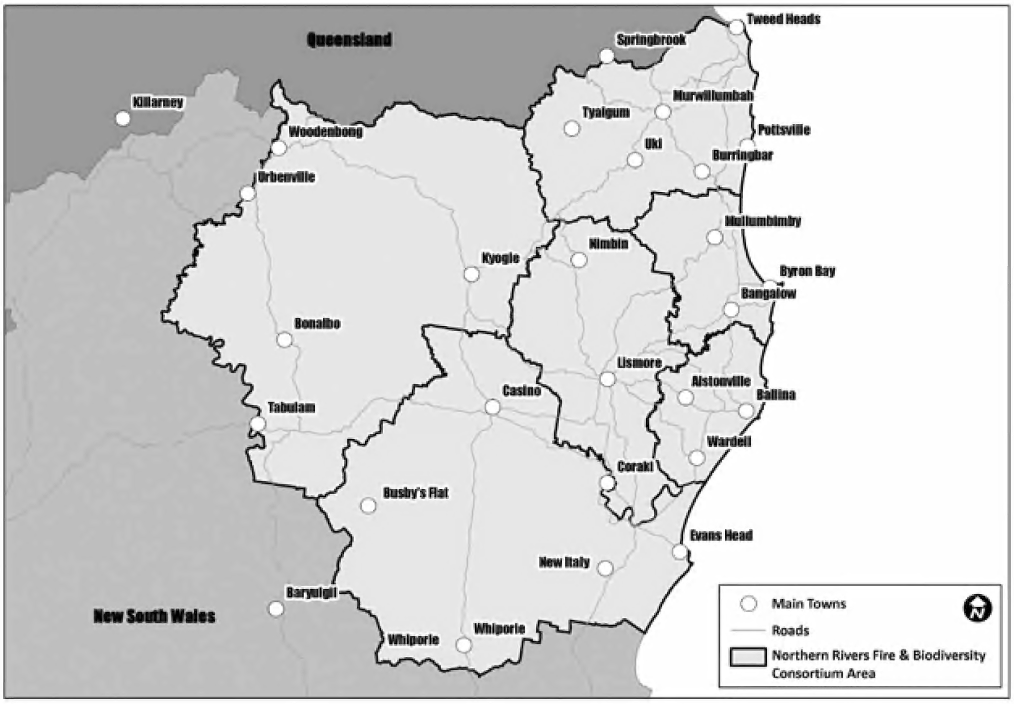
The Northern Rivers Fire and Biodiversity Consortium

The Northern Rivers Fire and Biodiversity Consortium (NRFBC) is a network of land managers and stakeholders seeking a coordinated, landscape level approach to fire management for biodiversity across the Northern Rivers region of NSW. This geographic area allows for efficient coordination and emphasis on fire-related dynamics within local vegetation types.

Consortium participants include State government agencies, local councils, and non-government organisations involved in biodiversity and fire management. The NRFBC works in close cooperation with the South East Queensland Fire and Biodiversity Consortium (SEQFBC),



Northern Rivers Fire and Biodiversity Consortium Area.

and encourages involvement by research institutes. The NRFBC provides a forum to:

- exchange information between stakeholders and other networks
- encourage a consistent landscape approach to managing fire for biodiversity
- support a collaborative approach to identify and implement fire-related projects and on-ground actions.

Since its establishment in August 2011 the NRFBC has successfully coordinated a number of on-ground and policy actions that have raised the profile of fire as a management tool for biodiversity conservation in the Northern Rivers. Working groups have been established to address:

- Bell Miner Associated Dieback (BMAD)
- Eastern Bristlebird habitat restoration
- protection of isolated Koala populations
- constraints to approval of ecological burns.

Each working group of cross organisational representatives strategically targets hurdles that have stalled the progress of activities leading to positive fire-related environmental outcomes. This collaborative framework has resulted in improved coordination and leveraging of resources and efforts to raise the role of fire as an important restoration tool for managing biodiversity conservation.

The Consortium in action: Eastern Bristlebird habitat restoration case study

Funded by the Commonwealth's Caring for our Country program an alliance between the NRFBC, SEQFBC and SEQ Catchments was formed to deliver the project 'Restoring habitat for nationally threatened species in the Border Ranges region'. An identified priority in the Border Ranges Rainforest Biodiversity Management Plan (DECCW 2010), this project aims to implement targeted fire and weed management strategies to restore habitat for the Eastern Bristlebird (*Dasyornis brachypterus*).

Only 20-30 Eastern Bristlebirds remain in the Border Ranges area. Appropriate reintroduction of fire is critical in managing this population Photo: Roger Williams 2013 (www.birdlife.org.au)

Project delivery includes stakeholder collaboration to:

- identify priority areas of known Eastern Bristlebird habitat and of other threatened species including the nationally listed Hastings River mouse (*Pseudomys oralis*) and NSW listed Eastern Chestnut mouse (*Pseudomys gracilicaudatus*)
- implement fire and weed management strategies to control weed and shrubby acacia encroachment
- conduct pre and post burn fauna and flora surveys to monitor populations and vegetation responses.

In NSW, the NRFBC was central in the delivery of a Hotspots community fire management workshop program (http://hotspotsfireproject.org.au/) to provide landholders with the skills and knowledge to undertake fire management planning and implementation for the enhancement of Eastern Bristlebird habitat.

Located approximately 35 km north of Kyogle, three contiguous properties along Gradys Creek adjacent to Border Ranges National Park, were identified for the reintroduction of prescribed fire to improve habitat for the Eastern Bristlebird. Two of the properties have Eastern Bristlebird Habitat Management Plans with at least 80 hectares of known or potential habitat. The burn undertaken for this project will not only meet the objectives of these plans, but will also address priorities identified in the draft National Recovery Plan for the Eastern Bristlebird (OEH 2012) and the NSW Eastern Bristlebird Priorities Action Statement (http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10206).

The burn proposal and assessment

The majority of the proposed burn area includes grassy open semi-mesic wet sclerophyll forests with degraded areas impacted by environmental weeds; primarily Lantana (*Lantana camara*) and Crofton Weed (*Ageratina adenophora*) developing in dense thickets within the gullies and mid-slopes.

Up until the late 1980s the three properties were regularly burnt, with records suggesting fires occurred approximately every three to four years. These fires usually occurred during late winter or spring, being undertaken to promote new growth for grazing.

It is likely that without fire Eastern Bristlebird habitat condition will continue to decline given ongoing weed and shrub encroachment. On one property chemical weed control has been undertaken to control the spread of Lantana, Crofton Weed and Acacias. Collaborative efforts between the Northern Rivers Catchment Management Authority and this project have enabled weed control to be extended across the adjoining two properties to maximise the effectiveness of the proposed burn across all three sites.

A low to moderate intensity fire is planned to remove ground fuel and impact weed and acacia regrowth. The timing of the fire will avoid the Eastern Bristlebird breeding season of August to December and follow up weed control work is scheduled post fire.

In NSW, unless specifically exempted, prescribed burns must undergo environmental assessment. For hazard reduction burns private landholders can apply for a Hazard Reduction Certificate; a streamlined assessment and approval process undertaken by the NSW Rural Fire Service.

However, if the intended burn is not exempt nor does it demonstrate hazard reduction benefits, there is currently no clear burning approval process. Ecological burns are specifically excluded from assessment under the hazard reduction approval process, meaning private landowners must seek alternative authorisation under relevant environmental legislation.

For this proposal a Hazard Reduction Certificate could not be issued. With no streamlined assessment available, it was important to ensure that all relevant legislation was considered prior to the burn occurring. This included:

- protection of Aboriginal and cultural heritage
- pollution prevention
- soil erosion considerations
- controlling the spread of weeds
- adhering to any existing land management agreements.

As there was a number of nationally and state listed species identified, a licence under Section 91 of the Threatened Species Conservation Act 1995 was required. Issue of a licence requires considerable justification to show that an ecological burn will not ‘harm threatened species, populations, ecological communities or damage their habitats’. Reliant on the underpinnings of detailed scientific justification, this process was undertaken by the NRFBC on behalf of the landholders.

In addition to State legislation, assessment of the impacts to threatened species listed on the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 was also considered.

Conclusion

To date there have been relatively few resources invested in initiatives such as the NRFBC that promote sustainable fire management policies and programs.

The delivery of the Eastern Bristlebird project has highlighted several challenges facing landholders and land managers seeking to implement ecologically based burns for conservation and landscape resilient outcomes. This is despite an increasing recognition that fire is not only a fundamental driver that shapes our ecological communities but also plays a critical role in biodiversity conservation.

This case study demonstrates that without the collaborative support of stakeholders that the Consortium model facilitates, achieving the objectives of projects that include ecological fire is difficult, particularly on private lands. The NRFBC shows that the cooperative alliances it cultivates can help to overcome such obstacles and progress a range of projects to deliver biodiversity outcomes.

Acknowledgement

Participants on the NRFBC are thanked for their contributions to the Eastern Bristlebird and other Consortium projects.

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Preliminary results suggest fire is required to maintain *Acacia dangarensis*, a threatened single-population endemic from the Hunter Valley of NSW

Stephen Bell[1]**and Max Elliott*[2]

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Many species of *Acacia* require fire to rejuvenate populations and to break dormancy in seeds, although other processes (diurnal temperature fluctuations, animal ingestion etc) may also be acting (Cavanagh 1980). With each passage of fire, a new generation of *Acacia* plants often germinates and re-builds ecosystems, ensuring maintenance of that species in the locality. But can we assume that introducing fire to a landscape will successfully stimulate the next cohort of individuals? A research project co-ordinated by the NSW Office of Environment and Heritage (OEH) has recently commenced to examine this issue for a threatened single-population endemic from the Hunter Valley of New South Wales.

Acacia dangarensis

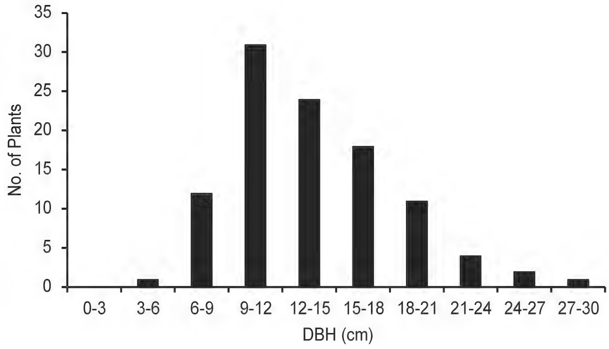
Acacia dangarensis is a long-lived small tree, first described around twenty years ago following initial collections made in the 1970's and 1980's (Tindale & Kodela 1991). It is currently listed as a vulnerable species on the NSW *Threatened Species Conservation Act 1995*, and occurs only on the slopes of Mt Dangar within the Goulburn River National Park. Mt Dangar is a rugged basalt peak rising to a height of 600m ASL within a wider landscape of Triassic Narrabeen sandstones and shales, at the northern end of the Sydney Basin. The sandstone landscapes within the northern Sydney Basin (including Wollemi, Yengo & Goulburn River National Parks) support numerous incursions of basalt, and although extensive plant survey has occurred there, no additional populations of *Acacia dangarensis* are known.

Ecological studies on *Acacia dangarensis*

During weed management activities on Mt Dangar in 2012-13, OEH staff noticed a lack of juvenile plants within the population of *Acacia dangarensis*, raising concerns that some active management may be required to ensure its long-term survival. Apart from expeditions to Mt Dangar to sample this and other threatened plant species, no field studies on the ecology of *Acacia dangarensis* have yet been completed. The conclusion that burning the slopes will provide the necessary stimulus for new germination is an easy assumption to make, but without hard data in support this may be detrimental to the population. With funding from the OEH *Find It and Fix It* program, the project aims to collect baseline ecological data on this species, with a view to informing management into the future, including an assessment of the role of fire in its life history.

To date, assessments of the population age structure of *Acacia dangarensis* shows that it is an ageing stand with limited replenishment. Despite evidence of good flowering and fruiting, extensive germination from the seed bank has not occurred. Seed bank studies revealed densities of around 20 seeds/m^2, which is comparable with results obtained by other workers on threatened *Acacia* species (eg: Elliott *et al*. 2002; Yates and Broadhurst 2002; Jusaitis *et al*. 2009).

Acacia dangarensis *in flower. Photo: M.Fagg*



Size distribution of Acacia dangarensis *on the southern slopes of Mt Dangar (n=104)*

Greenhouse-germinated seedling of Acacia dangarensis*, 28 days post-sowing. Photo: Max Elliott*

As with most *Acacia* species, the hard seed coat on this species requires fracture or breaking to induce dormancy and stimulate germination. A single seedling collected within one soil sample suggests that an occasional seed does germinate, perhaps through natural abrasion or predator damage of the seed coat. Preliminary germination trials during April 2013 showed a success rate of 83% (n=6) following overnight soaking after boiling water treatment, suggesting that exposure to fire is likely to induce new recruitment into the population. More comprehensive germination studies are planned for the coming Spring.

The likely role of fire

Intense wildfire has not occurred on Mt Dangar for at least twenty years, and probably much longer than this. As with many other small tree *Acacias*, it is likely that fire events replenish the population of *Acacia dangarensis*, simply through removal of standing biomass and stimulation of the soil seed bank. Preliminary germination experiments conducted as part of this study show that only moderate heat treatment is required to break dormancy, and with a seed bank density of 20 seeds/m^2, a sizeable seed bank is already present in the soil.

The slopes and summit of Mt Dangar generally support a grassy woodland or open forest dominated by *Eucalyptus moluccana* interspersed with varying densities of *Acacia dangarensis*, and with some patches of dry rainforest. Shrub species are relatively uncommon, but the ground layer comprises a consistent mosaic of herbs, forbs and grasses amongst the basalt scree. Such a structural composition of vegetation will rarely support fires, at least on the more protected southern slope, except under the driest of conditions. The northern slope, however, is observably dryer and may well carry a fire of sufficient intensity to stimulate new recruitment of *Acacia dangarensis*.

Much like this species, many other small tree Acacias are characterized by often even-aged stands that have responded to previous disturbances, such as wildfire. In the Hunter region, good examples include the thickets of *Acacia binervia* in northern Wollemi and Tomaree National Parks, *Acacia doratoxylon* in and around Manobalai Nature Reserve and Goulburn River National Park, and *Acacia bulgaensis* and *Acacia fulva* in Yengo and Wollemi National Parks. In all of these cases, mass germination of soil-stored seed following fire events has resulted in the development of near-even aged stands of a single *Acacia* species.

Conclusions

Although the results discussed here are preliminary only, it is apparent that the population of *Acacia dangarensis* on Mt Dangar flowers and fruits freely, and that the ample seed bank germinates well with limited heat stimulation. The ageing population suggests that new recruitment will be necessary in the coming years, and that fire is likely to be the agent to deliver this. The challenge for OEH, however, is how best to introduce fire into an environment that will burn only under the driest of conditions, and how frequent these fires need to be: a fire once every few decades is probably adequate to maintain this species at Mt Dangar. Management decisions such as this will only be made after continuing studies on seed viability and germination, flowering and fruit phenology, and population counts shed more light on the ecology of this species.

Acknowledgements

Thanks to Greg Lowe from the NSW Office of Environment and Heritage for project initiation and support, and the *Find it and Fix it* program for funding.

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Preliminary field observations on fire and the endangered and data deficient *Pultenaea* sp. *'Olinda'*

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Introduction

Pultenaea sp. *'Olinda'* is an erect to procumbent shrub reaching a height of 0.5-1m with a similar spread. The needle like leaves are 5-10mm long and 0.5-1mm wide. It bears 'egg and bacon' pea flowers with a bright yellow standard and red/brown keel in spring. The fruit is 5-6mm long. The species has a restricted distribution east of Rylstone in the NSW Central Western Slopes botanical subdivision where it is confined to ledges and clefts associated with pagoda rock formations within a matrix of Eucalypt woodland. It occurs as a component of heath communities with or without a sparse *Eucalyptus* and/or *Callitris* canopy. Soils are shallow, sandy and infertile. *P.* sp. *'Olinda'* was listed as an endangered species under the NSW *Threatened Species Conservation Act* in 1998.

During June-Aug 2012, this author discovered a number of new locations supporting this taxon. Fortuitously some of these sites had been burnt a few years previously allowing preliminary field comparison between burnt and nearby unburnt sites. This has provided insights into key aspects of the previously unknown fire ecology of the species. As fire is the most widespread, recurrent disturbance occurring across the species' distribution, an understanding of its' fire ecology is considered essential as appropriate fire management is likely to prove fundamental to ensuring this species remains viable in the wild.

Preliminary observations on fire ecology

Field observation confirms *P.* sp. *'Olinda'* is a geospore. Accessions to the soil stored seedbank appear to occur on an annual basis. The presence of juveniles in burnt sites together with their absence from unburnt sites points to fire cued recruitment. As with many Fabaceae from fire prone environments, seeds of *P.* sp. *'Olinda'* appear to possess a hard impermeable seed coat that imposes a physical dormancy that is overcome when the seed coat is cracked by the heat of a fire. Fire therefore, appears to play a pivotal role in providing recruitment opportunities and perhaps early competitive advantage in the post fire environment. More significantly perhaps, the presence of large, multi-stemmed, reproductive individuals amidst a scattering of small, single stemmed, non-reproductive juveniles in burnt sites points to post fire resprouting (contrary to expectations that the species would prove to be fire sensitive). Living stems have been positively associated with the bases of charred stems killed by 100% crown scorch thus confirming the resprouting habit.

Pultenaea *sp.* 'Olinda'.
Photo: Steve Clarke

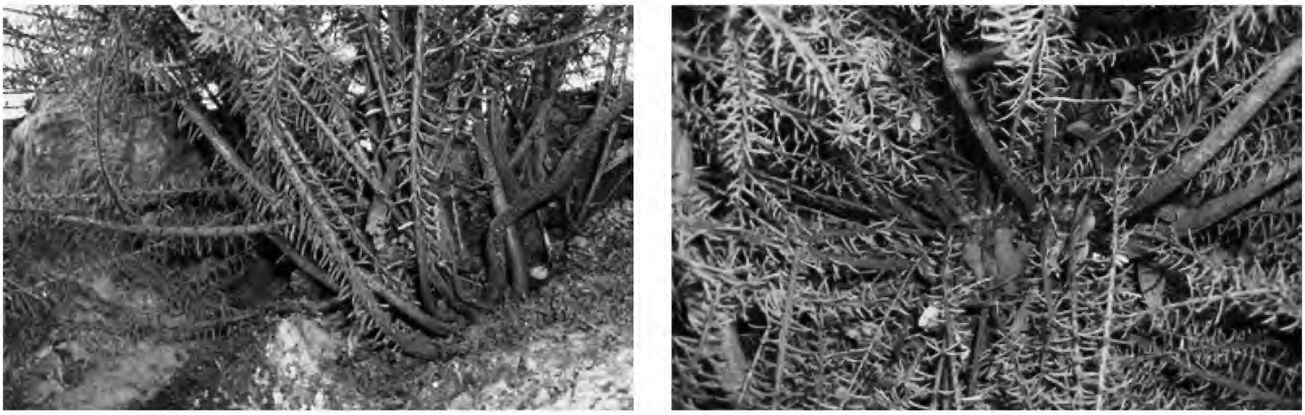
Small numbers of empty fruits have been observed persisting 6-8 months after seed dispersal. The absence of such fruits on resprouting plants indicates that 2012 may have been the first post fire flowering season.

The wildfire that affected these sites occurred in the 09/10 fire season indicating a secondary juvenile period (time from resprouting to first flowering) of 3 years although this is likely to vary depending on average environmental conditions in the first few years post fire. While data is required to quantify the effect of fire on growth and fecundity, initial field observation indicates long unburnt plants are woody with small numbers of leaves and flowers crowded near the branch tips whereas resprouting plants have leaves along the entire length of the branches, many more flowers and appear much more vigorous and healthy than unburnt plants.

Further research questions

The following research questions reflect significant gaps in current knowledge relating to the fire ecology of *P.* sp. *'Olinda':*

- What is the average lifespan of an individual?
- What is the primary juvenile period? (time from seedling emergence to first flowering/ability to resprout). This would give some indication of what minimum fire interval would be appropriate.
- Is the ability to resprout a general trait or restricted to certain populations as is known to occur in other species?
- Are a percentage of adults killed during the passage of a fire and how might this vary with fire intensity?
- What is the magnitude of fruiting in relation to time since fire, plant age and plant size?



Multiple stems arising from the bases of burnt plants after 100% crown scorch. Photos: Steve Clarke

- What is the percentage of viable seed set?
- Are rates of pre and post dispersal seed predation significant? Losses to predation of entire first post fire seed crops have been reported for other Fabaceae. This has implications for calculating minimum fire intervals.
- What is the longevity of soil stored seed? This would give an indication of what maximum inter fire interval would be appropriate.

Fire related threats

While the ability to resprout gives some insurance against occasional short fire intervals, field observation suggests inappropriately long fire intervals may be occurring across much of the species distribution. As there is a high public/private land interface across this species' distribution, the area is subject to periodic hazard reduction burning. Contrary to normal expectations, this may be imposing an inappropriately low fire frequency as low intensity fires burning under benign weather conditions are unlikely to invade the protected niches inhabited by this species. Furthermore, if such fires do reduce the frequency and intensity of wildfires burning under conditions of high temperature and wind, when embers raining down as incendiaries *are* likely to invade these niches, fire disturbances could be being limited even further. Given that seed germination appears to be fire dependent, this type of fire management and the suppression of natural ignitions may be inducing an artificial recruitment limitation on this species. Interestingly, where *P.* sp. *'Olinda'* occurs with *Leionema sympetalum*, which also has fire cued germination, individuals of both species are old and woody with no evidence of recruitment for many years. Targeted burning of niches containing this species may be a viable strategy for overcoming this problem.

Conclusion

In 1998, the NSW Scientific Committee cited evidence of decline over the previous 40 years as one of the reasons for listing this species as endangered. Given that nothing was known of its ecology at the time, and it was suspected to be fire sensitive, a cautious approach in interpreting any loss of individuals and/or contraction of range as 'decline' is understandable and justified. Had there been a real decline (loss of individuals and propagules) or was perceived decline related to replacement of above ground plants with soil stored seed with increasing time since fire as old plants die? While knowledge of its' ecology is still rudimentary, in this authors' opinion, the passage of a moderate/high intensity fire over parts of its range that have not seen such a fire for many years may be all that is required to substantially recover this species in the wild. As has been demonstrated in the sites burnt in 09/10, such a fire has the potential to rejuvenate the vegetative vigour and reproductive fecundity of old woody plants via resprouting and produce a pulse of seedlings. It is also possible the species may appear in 'new' sites that may still contain viable soil stored seed but from which all above ground plants have long since died. Such a fire could demonstrate that populations of *P.* sp. *'Olinda'* are resilient and self-sustaining given appropriate fire management. While that in itself may not be sufficient to warrant the removal of *P.* sp. *'Olinda'* from the endangered species list, as numbers would still be low and distribution limited, we may be able to breathe a little easier in regards to its' long term future.

Acknowledgements

The assistance of Michelle Barton from the NSW Office of Environment and Heritage in providing fire history maps is gratefully acknowledged.

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Vegetation monitoring and management at Kinglake National Park following the 2009 Black Saturday Bushfires

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Introduction

The 2009 Black Saturday bushfires affected up to 95% of Kinglake National Park (KNP), situated in the western section of the Victorian highlands. The fire burnt across much of the park in several hours and in places reached intensities never before recorded in Victoria's history. In the aftermath of the fire event, the sheer scale and intensity of the bushfire raised some important and concerning questions for the local land managers, Parks Victoria:

- How had the fire affected populations of threatened plant taxa and vegetation communities?
- Were these populations and communities at immediate risk from other processes in the post-fire period?
- If they were at risk, what could be done to prevent further decline?

In an effort to respond to these questions, Parks Victoria initiated a vegetation monitoring and recovery program which began several months after the fire event and has continued until the present. This article discusses some of the challenges and responses encountered during the program and uses individual plant taxa and communities as case studies.

Swamp Bush-pea (*Pultenaea glabra*) – Nationally Vulnerable

Overview

Swamp Bush-pea is endemic to Victoria where it is known from several widely scattered locations. The species has been eliminated from many of its former occurrences by logging and land development. In KNP, Swamp Bush-pea is only known from one population in an area of damp heathy woodland which was burnt at high intensity during the bushfire.

Fire response

The entire adult population was killed by the fire, however abundant seedling recruitment soon followed. The first seedling recruitment occurred in April 2009 in low lying swales, but a rain episode in June caused sheet erosion of the upper slopes, leading to deposition of silt onto seedlings resulting in their death. In August there was a second recruitment event and several thousand seedlings germinated.

*The nationally threatened Swamp Bush-pea (*Pultenaea glabra*). Photo: Carl Just*

Management

Despite the high density of seedling recruitment, Parks Victoria was concerned that browsing pressure from native and feral herbivores such as Goats (*Capra aegagrus hircus*), Sambar Deer (*Rusa unicolor*) and Black Wallaby (*Wallabia bicolor*) would eliminate plants. If the adult population were killed, this could be detrimental if the fire had exhausted the soil seed-bank. To prevent grazing pressure, four 1.5 metre high exclusion fences were constructed around the majority of the population. These have been highly successful and in spring 2010 the population reached maturity and flowered profusely, later dropping large quantities of seed. The population is now considered to be relatively secure.

Fairy Lanterns (*Thismia rodwayi*) – Vulnerable in Victoria

Overview

Fairy Lanterns is arguably one of Australia's most cryptic plant species. The body of the plant spends most of its life cycle below the ground, producing bright red flowering structures that appear below leaf litter. The species is believed to be dependent on mycrrohizal fungi that mostly grow under thick beds of leaves of the Musk Daisy Bush plant (*Olearia argophylla*). At KNP, Fairy Lanterns is only known from one population in wet forest on the upper slopes of Mount Disappointment.

Fire response

Survey of the site several months after the fire revealed that all above ground parts of Musk Daisy Bush plants and surrounding leaf litter had been completely burnt. In the years that have followed, the habitat of this area has been drastically transformed by extremely dense regeneration of Mountain Ash (*Eucalyptus regnans*) saplings. Not surprisingly the *Thismia rodwayi* has yet to be relocated. Future monitoring of this site may help to answer currently unknown aspects of its ecology: is it eliminated completely by hot fires, or is it a mid-late succession specialist, only growing when large (and possible old-growth) groves of Musk Daisy Bush re-establish?

Cool Temperate Rainforest of the Plenty River

Overview

The western section of KNP includes the Mount Disappointment reference area, an area of tall wet forest that has been reserved as protected water catchment since 1881. The reference area contains the twin headwaters of the Plenty River which supports the most westerly occurrence of cool temperate rainforest along the Great Divide. Prior to the 2009 bushfire, this rainforest stand was believed to have remained unburnt for almost 300 years.

Fire response

The extreme conditions on Black Saturday created severe fire storms that affected nearly every gully in the park, including the Plenty River headwaters. The rainforest stand was burnt at high intensity, killing many of the dominant Myrtle Beech (*Nothofagus cunninghamii*) trees and severely affecting the understorey. Monitoring since the fire has revealed that a large suite of rainforest-dependent plants have been temporarily eliminated, particularly fern species. The understorey has become dominated by thick regeneration of wet sclerophyll forest species, drastically transforming the original structure and composition of the rainforest and increasing the risk of further fires. It is predicted that many of the rainforest taxa will not recolonise the gully unless it is protected from further fire for at least another century. Ongoing monitoring will be essential to document the recovery of this important rainforest site.

Mountain Ash wet forest following fire. Photo: Karl Just

Management

A small number of Myrtle Beech (*Nothofagus cunninghamii*) plants were propagated and replanted at the site to assist in the long-term recovery of the rainforest. Re-shooting Sassafras (*Atherosperma moschatum*) trees had to be fenced to protect from severe browsing by Sambar Deer (*Rusa unicolor*), Black Wallaby (*Wallabia bicolor*) and Bobuck (*Trichosurus cunninghami*).

Mountain Ash forests of Mount Disappointment

Overview

Mount Disappointment supports a large stand of Mountain Ash (*Eucalyptus regnans*) which is relatively disjunct from the heartland of these forests to the east. Prior to the fire it was believed to be the largest stand of unlogged, old-growth ash forest in Australia. This stand supports some of the tallest hardwood trees in the world, including individuals reaching over 93 meters. Mountain Ash is a fire-sensitive species that normally dies if the canopy is affected, followed by mass recruitment from seed held in the canopy.

Fire response

The 2009 bushfire burnt through the entire stand of these trees, leading to the loss of some very old individuals that were believed to have originated from previous fire events in the early 1700s and 1851. Despite the sad loss of these trees, there were some interesting findings from the post-fire study of these forests. Surprisingly, a few small stands of Mountain Ash survived the fire, likely due to their tall height and a chance event in fire behavior (such as a sudden wind change) so that their canopies remained un-scorched. Another theory has been proposed by researchers that the Mountain Ash of Mount Disappointment are more resilient to fire than other stands of these trees to the east due to their close proximity to surrounding dry sclerophyll forests (i.e. an evolutionary adaptation) (Tony Fitzgerald pers. comm.).

The regeneration of the wet forest understorey was fascinating to record. Within six months the tree ferns had re-shot and the ground was a carpet of green. Several herb and grass species that had never or rarely been recorded in the area germinated in massive numbers in the first 18 months. These species flowered and seeded prolifically before virtually disappearing again. Their seed will no doubt remain in the soil until the next fire event.

Conclusion

The post-fire vegetation surveys at KNP documented valuable information on the ecology of threatened flora and vegetation communities and identified potential risks in the post-fire period. This enabled Parks Victoria to undertake recovery management that included fencing to exclude herbivores, weed control works to reduce competition and replanting. The project highlighted the importance of ecological surveys in the post-fire period, to increase our knowledge of plant ecology and arrest threatening processes. Further monitoring in the long-term is required to assess the full impact of the fire on some threatened plant species and communities.

Acknowledgments

We would like to thank Tony Fitzgerald, Natalie Brida and Ion Maher (Parks Victoria) for coordinating the project and providing important contributions.

The response of Grampians Duck-orchid and Grampians Pincushion Lily in Victoria to wild fire

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Introduction

Specific detail on fire responses of individual species are often not known or recorded in the literature. Australia's flora is well adapted to wild fires and in many circumstances wildfire is an essential event in the lifecycle of a species, though this is not always the case. Perhaps some species are rare in our landscape due to their inability to respond well to wildfire. Fire is often listed as either a threat to endangered species under Federal Recovery Plans and State Action Statements or as probably beneficial or in need of further study. Threatened species, with small often isolated populations facing numerous threats, may not always have the capacity to recolonise effectively after a stochastic event like wildfire.

Grampians Duck-orchid

Grampians Duck-orchid (*Paracaleana disjuncta*) is sparsely distributed in Victoria, South Australia and Western Australia and is listed under the *Flora and Fauna Guarantee Act* 1988 and ranked under IUCN on CRITICALLY ENDANGERED. Two sites in Victoria are known from within the north and south of the Grampians (Gariwerd) National Park consisting of less than 350 plants in total. Within the Adelaide and Mount Lofty Ranges region of South Australia it is extremely restricted. The species has also been recorded from 10 locations within Western Australia between Margaret River and Israelite Bay. This charismatic Duck-orchid grows to 15 cm tall, with 1 or 2 small, dull reddish brown flowers.

Grampians Pincushion Lily

Grampians Pincushion Lily (*Borya mirabilis*) is listed under the *Flora and Fauna Guarantee Act* 1988 and as Endangered under the *Environment Protection and Conservation Act* 1999. It is a perennial herb and one of the world's most endangered plants (IUCN, 2001). The entire natural population consists of five colonies (Kohout and Coates, 2010) on one rock outcrop in the Gariwerd National Park and is not known to produce seed. The species has been successfully reintroduced into a second site within the Gariwerd National Park.

Response to fire

The January 2006 Mt Lubra bushfires in the Gariwerd National Park and the January 2010 Roses Gap bushfire, allowed a unique chance to record the response of these two species to wild fire on sites that had been monitored prior to the fires. Both fires burnt particularly hot on the monitoring sites, with close to 100 % canopy scorch at both sites. The fire response of both of these species has not been well documented previously and it is hoped the information attained should assist their fire management.

Methods

Grampians Duck-orchid

In June 2009 a monitoring quadrat was established with each Grampians Duck-orchid plant tagged and its location within the quadrat measured. Leaf emergence in June, flowering in November-January and seed set in December-February each year were recorded. In January 2010 a wildfire went through Roses Gap. A total of 144 plants were included in the 2009 monitoring quadrat, with any additional plants within the quadrat emerging in subsequent years being added. The number of plants present (leaf/flowering/seed set) pre and post fire have been compared and analysed using Genstat 15.0.

Left: Grampians Pincushion Lily turns a brilliant orange colour as it goes into summer dormancy.
Right: Grampians Duck-orchid flowering in December in the Gariwerd National Park. Photos: Noushka Reiter

Grampians Pincushion Lily

In 1999 a monitoring site was established for the Grampians Pincushion Lily by Fiona Coates and the Recovery Team. The point intercept method was used to record the presence of plant tissue as alive or dead and the absence as void over the monitored area, essentially measuring the extent of the individual colonies. Monitoring was initially four times a year, was reduced to twice a year and is currently once a year. In 2006 the Mt Lubra wildfire burnt the site.

Results

Grampians Duck-orchid

Less than 20 % of the Grampians Duck-orchid population has recovered post fire. The fire has caused a severe and significant reduction in the Roses Gap population (ANOVA $P<0.05$). The number of plants flowering post fire was lower than pre fire, however, the proportion of surviving plants that were flowering was higher and due to the initial reduction in surrounding vegetation they were more easily seen.

Monitoring at the southern site not burnt in 2009 and only discovered post the 2006 Mt Lubra fires, revealed no significant change in plant numbers between 2009 and 2012. This suggests that the decrease in population is unlikely to be due to other environmental factors such as rainfall. Ninety per cent of plants in the southern population are being predated before seed set. The Roses Gap site has minimal predation.

Grampians Pincushion Lily

The Grampians Pincushion Lily was able to survive fire and remerged from its rootstock and six months post fire plants had some sign of growth. By 2009, 90% of the entire population was dead or void and only 10% alive, compared to 39 % of the population alive prior to the Mt Lubra fire. By 2012, 29 % of the population was alive. There was no increased flowering response post fire.

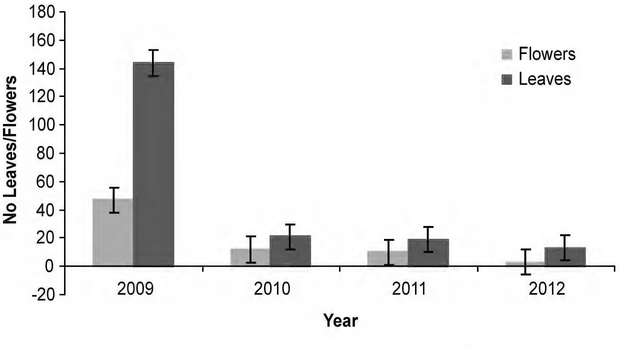
Discussion

Grampians Duck-orchid

Over 80 % of the Grampians Duck-orchid population has not recovered post fire. Fires of this intensity have been shown to be a significant threat to this species and should be included in the management of this species. The Department of Environment and Heritage (2008) suggest that fire may be beneficial, while Duncan *et al.* (2009) is more cautious implying it is in need of further research. These monitoring observations can confirm that fire has had an adverse effect on this species.

Grampians Pincushion Lily

Since 2006 the population of Grampians Pincushion Lily within the Gariwerd National Park has yet to recover to its former size post the 2006 fires. The shade that was provided by vegetation has yet to return and one of the five colonies did not return at all post fire. This colony was already infected with *Phytophthora cinnamomi* and combined with drought conditions in the following two years, post fire is likely to have compounded the effects of the fire. Coates (2000) lists fire as a potential threat, while Kohout and Coates (2010) state that the population is showing good



Grampians Duck-orchid leaf emergence and flowering pre wildfire (2009) and post wildfire (2010-2012).

signs of recovery. The monitoring observations show fire, has had a compounding effect with other threats onsite and is detrimental to the persistence of this species.

Acknowledgements

We would like to thank the *Borya mirabilis* Recovery Team, Parks Victoria, Caring For Our Country funding, Department of Sustainability and Environment, Wimmera Catchment Management Authority and Friends of the Grampians.

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Improving the management of native orchid populations

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Introduction

Open any book about Australian terrestrial orchids, and it is easy to find statements like “The plants found in recent years were growing in damp sedgy heath that was recovering from a hot summer fire.” (Jones *et al.* 1999). This example relates to the critically endangered species *Prasophyllum pulchellum* (Threatened Species Unit 2001), which is endemic to Tasmania. This paper is concerned with how to convert these types of statements into effective management actions to sustain a population of threatened orchids, using the example of *Prasophyllum pulchellum*.

Background

We purchased Rubicon Sanctuary in central northern Tasmania in 2007. The Tasmanian Land Conservancy had previously acquired the property and attached a covenant and Nature Conservation Plan to the title. The Plan prescribes periodic burning to manage threatened species, including several orchid species.

On-going management of high-quality remnant bushland is very different to a typical restoration project. At the end of our stewardship at Rubicon Sanctuary the bushland should be in similar condition to when we acquired it. However, we do plan to improve the knowledge about how to manage “our” threatened species. As native orchids are a major feature of the property, we have prioritised a better understanding the population dynamics and life history of our five threatened orchid species. The effect of natural (e.g. drought) and anthropogenic (e.g. planned burning) events can potentially be teased out given sufficient longitudinal monitoring data (Coates *et al*. 2006; Coates and Duncan 2007).

Definitions and aims

All of the threatened and poorly known orchid species at Rubicon Sanctuary are perennial terrestrial plants. A typical life cycle involves annual renewal of an underground tuber and, potentially, seasonal emergence of a leaf and/or flower stem. Dormancy is a stage in a plant’s lifecycle when it emerges in season one, then fails to emerge for one or more subsequent seasons, followed by re-emergence. When managing threatened orchid species it is highly desirable to avoid multi-seasonal dormancy because it is positively correlated with increasing mortality (Coates *et al*. 2006). In remnant habitats, especially where the number of known populations and/or population sizes are relatively small, it seems desirable to encourage flowering and fruiting to enable recruitment of new plants, but not at the expense of increased mortality that may arise from exhausting the existing plants. Disturbance by hot fires (e.g. Jones *et al.* 1999) is frequently mentioned as a natural process that promotes flowering and presumably also interrupts any dormancy. We aim to better understand how best to use fires and to explore other options for disturbance.

Method

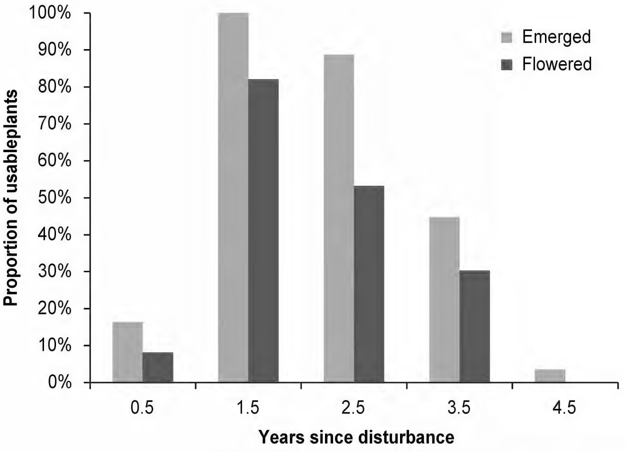
At Rubicon Sanctuary we have burnt patches up to about 1 ha in most years since 2007, initially with the invaluable assistance of the Tasmania Fire Service. Burning is the preferred option for broad-scale disturbance of our sedgy heathland where most of our threatened species grow. All of our fires have been conducted in early April, to balance the recommendation for a hot fire with a high degree of control. This is likely to be an enduring constraint, and potentially an important change from the prior folklore about burning in summer.

Our initial burn-offs were mostly to re-confirm oral history about the locations of key populations. As individual plants were re-discovered, we installed a numbered brass tag beside all or a sample of plants from each priority species. We subsequently record demographic information about each plant three times a year: at leaf emergence, flowering time, and fruiting time. We use transects or metal stakes to ensure that every tag is re-located each year, whether in the increasingly dense unburnt sedgeland or in the open after disturbance.

Our re-discovery phase merged into a management phase in 2012, when we burnt for the second time one of our "orchid hot spots" that was previously burnt in 2007. This area is the home of one of two then-known sub-populations of *Prasophyllum pulchellum* plus other threatened and poorly known species. We had previously documented a dramatic decline in emergence and flowering of *Prasophyllum pulchellum* between 2007 and 2011, which was the motivation for selecting this area to burn again.

Results

By the end of the 2012 season, we had tagged all 141 plants of *Prasophyllum pulchellum* that we had discovered. Numbers had built up from 6 known plants in 2008, to between 60 and 80 plants between 2009 and 2011. Observations from a few of these tags are deemed to be unusable after the plant tubers were seen to have been dug up. We examine data about the emergence and flowering response from all usable plants in the period 2008 to 2012. Many plants have contributed demographic data for several years giving a total of 351 observations, including 196 (56%) emergence and 139 (40%) flowering observations. We partition these observations by the number of years since the most recent disturbance. *Prasophyllum pulchellum* plants infrequently emerged in the spring immediately following (i.e. 0.5 years after) fire. Peak flowering occurs in the following spring, and nearly all plants became dormant by the fifth season after fire. This is consistent with advice about this species in orchid field guides.



The relationship between the number of years since the most recent disturbance and the proportion of Prasophyllum pulchellum *plants that are observed to have emerged or emerged and flowered. There are between 57 and 95 observations for each of the periods (0.5, 1.5, 2.5, 3.5, or 4.5 years) after disturbance*

Flower spike of Prasophyllum pulchellum. *Photo: Phil Collier*

The results are subject to several limitations:

- Data is longitudinal, but treated as cross sectional;
- '0.5 years' since disturbance is the only category to include plants that had been discovered and tagged prior to the most recent disturbance. In particular, '1.5 years' since disturbance includes numerous instances of flowering plants being newly discovered, including 55 plants that were discovered in 2012 following a 2011 burn.
- The '0.5 years' and '1.5 years' counts include observations that result from disturbance by slashing. However, the limited results to date from slashing are consistent with the results from burning.

Discussion

On the basis of the results presented, we predict that the *Prasophyllum pulchellum* plants that were disturbed by burning or slashing in April 2012 will achieve their maximum extent of flowering in November 2013. If this is the case, and there is little evidence of plant mortality, then a four year disturbance cycle may be the best management regime for this species at our property. We have also conducted experimental disturbance by slashing to determine whether this has similar effects to disturbance by burning, so that slashing can be used locally when a larger burn-off may be infeasible or premature for other priority species in the area.

We have applied the same method to a small population of *Caladenia congesta* plants that we manage by slashing in a woodland habitat. Peak flowering again occurs 1.5 years after slashing, but declines significantly by 2.5 years. For *Caladenia congesta*, the repeat period for disturbance appears to be three years or possibly two years if this does not exhaust the flowering plants.

Acknowledgements

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Combining science with management: Understanding the seed ecology of 'Pearl-like Androcalva' underpins successful *in situ* regeneration by fire of this threatened species

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For many native species the triggers for dormancy loss and germination are poorly understood at best and for the vast majority of native taxa are currently completely unknown. Nevertheless, one of the more familiar triggers for stimulating native seed germination is fire. Whether it is through the direct actions of heat or the smoke produced as a by-product, fires have been an integral part of the Australian landscape for tens of thousands of years and for many native species fire is an essential element of the regeneration process stimulating the mass germination of long quiescent soil seed banks.

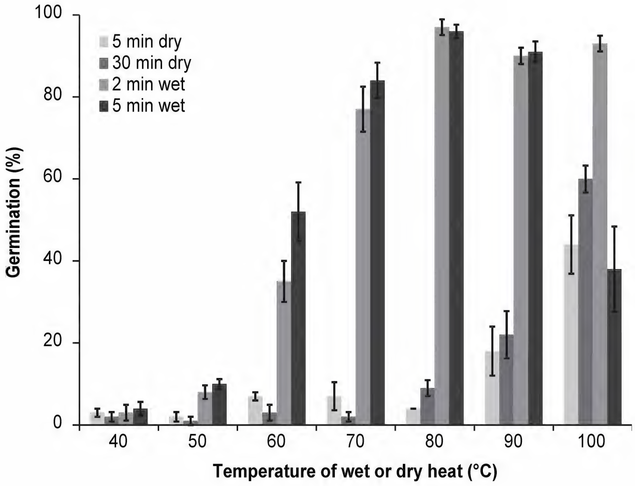
Germination cues for WA species

Western Australia currently has over 400 species listed as threatened and insights into their regeneration requirements are critical for their continued survival. It is likely that many have, and do form, a persistent soil seed bank. While most threatened species have not been studied as yet, in terms of their dormancy characteristics or their germination requirements, some broad conclusions can be made about their likely responses to known germination triggers, such as fire, based on the behaviour of closely related taxa and their overall taxonomic affinities. Taking a broad approach like this can be informative and from these initial calculations we find that up to 85 % of threatened WA species are likely to possess some form of seed dormancy making germination on demand for these species potentially problematic. Additionally, around 40 % of these threatened species are likely to be smoke responsive as well (i.e. will not germinate unless provided with a smoke cue) and 20 % may have a water impermeable seed coat (i.e. physical seed dormancy) as commonly observed in *Acacia* spp. and other legumes.

Pearl-like Androcalva

Pearl-like Androcalva *(Androcalva perlaria)* is one threatened species that prior to 1993 was completely unknown. Following its discovery and several extensive searches it is now recorded from just four small isolated bushland fragments on the Southern Coast of Western

Australia. Pearl-like Androcalva also appears to have specific habitat requirements being found only in seasonally waterlogged wetlands. It belongs to the Hibiscus (Malvaceae) family and is a semi-erect spreading shrub growing to 50 cm tall with small cream to white flowers from September to December. Across all known populations, less than 100 plants remain. The species is listed as Declared Rare Flora (DRF) under the West Australian *Wildlife Conservation Act 1950*. Altogether, there are just 33 species of *Androcalva* known, all of which are found in Australia, five are currently classified as threatened within Western Australia with an additional six species also recognised as threatened in other Australian states. The genus, while relatively obscure, is closely related to *Commersonia*, *Lasiopetalum*, and *Thomasia*, many of which are also known for possessing physical seed dormancy.



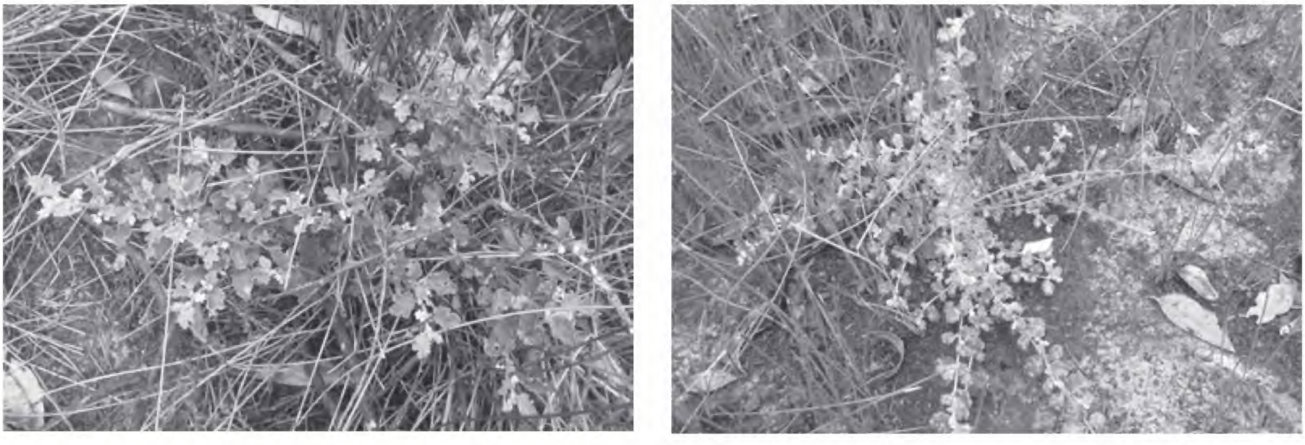
Average germination (% ± se) of Pearl-like Androcalva seeds following the application of different wet (water bath) and dry heat (dry sand in an oven) treatments. Image: C. Best

Seed dormancy mechanisms

Research since 2010 has seen the establishment of a large (~600 plants) genetically diverse *ex situ* potted collection of Pearl-like Androcalva plants which has been used to generate tens of thousands of seeds for conservation purposes as well as to investigate the seed biology of this species. One of the first findings was that the species produces significant quantities of highly viable seeds and that these seeds were indeed physically dormant with less that 20 % germination if left untreated. Subsequently, nicking or exposure to hot water (for as little as one second), significantly improved germination (> 90 %) which occurred rapidly once dormancy was broken, albeit at incubation temperatures less than 25 °C. Further investigations identified that wet heat was far more effective at breaking seed dormancy than dry heat, with the critical temperatures required for dormancy loss needing to be higher than 60 °C. Having identified these initial seed attributes, further investigation set about to identify the drivers of dormancy loss under natural conditions and the length of time seeds can persist. Seeds artificially buried in the soil seed bank (within the largest remaining natural population) have remained completely dormant for over two years. There has been no reduction in seed viability during this time and seeds have retained their capacity to readily germinate once exposed to heat. Likewise, seeds artificially aged under standardised ageing conditions (45 °C and 60 % equilibrium relative humidity) were found to be unusually long-lived (p_{50} (i.e. the time taken for a 50 % reduction in germination due to seed death) of ~270 days), placing the species in the top 15 % of native species in terms of their capacity to resist seed ageing processes.

Effects of prescribed fire

The final piece of the jigsaw was provided in September 2012 when a prescribed fire was undertaken by the Department of Environment and Conservation (DEC) in a site adjacent to the largest remaining population. While no plants were known from this location at this time, a single adult plant had been found there in 2006. Prior to



Left: Pearl-like Androcalva plant growing in situ. Photo: S. Turner.
Right: Pearl-like Androcalva plant seven months after a prescribed fire. Photo: C. Best

the burn in September, several data loggers were buried approximately 20 mm below the soil surface and recorded the soil temperature and moisture every minute during the passage of the fire. In summary, the temperatures experienced during the fire front rose very rapidly peaking at 66 °C for less than 2 minutes, a temperature that was clearly within the range that laboratory testing had proven to be effective for dormancy loss. The site was not visited again until December 2012 when ~20 seedlings (20 to 70 mm tall) were discovered. Comprehensive monitoring undertaken in April 2013 identified 29 seedlings (30-250 mm tall), occupying an area of 3000 m^2. Several of the seedlings were beginning to flower as well. The fire had successfully stimulated the germination of seeds which had been dormant in the soil seed bank for at least six years prior to the September 2012 burn.

Conclusion

Through a series of laboratory and carefully planned field experiments the seeds of Pearl-like Androcalva were found to have physical seed dormancy, remain dormant and viable when buried *in situ* for at least two to six years and require high temperatures for dormancy removal. This knowledge effectively served to plan, where, when and how this species could be stimulated to germinate in a location where it had not been seen for over half a decade with the outcome being the creation of a new population. Indeed, a little over six months since the burn and this new population is already flowering and in all likelihood will continue to do so for the next few years at least, replenishing the soil seed bank with a new generation of dormant Pearl-like Androcalva seeds.

The role of fire in plant conservation in wheatbelt remnants

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South-west Western Australia (WA) is renowned for its floristic richness and levels of endemism, but also for the degree of threat the flora faces. Since European settlement, native vegetation has been removed from large portions of the WA wheatbelt, for example. One of the many consequences of this fragmentation has been a disruption to the patterns and processes of fires.

In common with other Mediterranean-climate regions, fire has been an important feature of south-west WA for millennia. Together with soils and landforms, fire plays a key role in shaping the composition and structure of vegetation, through removing established vegetation, stimulating recruitment and initiating successional processes. These changes also affect the availability of habitat for fauna. Analysis of satellite imagery shows that fires are less frequent in vegetation remnants in the wheatbelt than in comparable continuously vegetated landscapes, and further, that fire occurrence declines with declining remnant size (Parsons and Gosper 2011).

Here, we describe recent research in two widespread communities, mallee and mallee-heath, aimed at understanding some of the consequences of this seemingly reduced frequency of fires in wheatbelt remnants. The mallee community is dominated by species that resprout after fire, with a canopy of mallee *Eucalyptus* spp. The mallee-heath community is dominated by non-resprouters (species that are killed by complete canopy scorch and must regenerate from seed after fire), particularly Proteaceae and Myrtaceae, with scattered emergent mallees. Remote sensing (via DEC Fire Management Services) was used to establish a chronosequence (space-for-time substitution) ranging from 2 to >55 (i.e. no evidence of contemporary fire) years since fire.

Changes in diversity and composition with time since fire

Understanding how vegetation communities change in diversity indices (richness and evenness) and plant functional type (PFT) composition with time since fire can provide useful insights into appropriate intervals between fires for biodiversity conservation. In mallee-heath, diversity indices showed monotonic decreases with increasing time since fire, consistent with the initial floristic composition model of plant succession following disturbances (Gosper *et al*. 2012a). Under this model, all species in the post-fire sequence become established after fire, and there is a gradual loss of species from the above-ground vegetation (i.e. these species retreat to the soil-stored seed bank) as a result of competition and longevity limits. There were no significant relationships between diversity indices and time since fire in mallee.

The response of aggregations of taxa in PFTs (according to traits relevant to vegetation assembly in fire-prone environments; plant longevity, resprouting capacity, seed bank persistence and location, and competitive stratum) were predictable in mallee-heath (Gosper *et al*. 2012b). With increasing time since fire, the cover of non-resprouting serotinous PFTs (e.g. *Hakea cygna*) increased, post-fire ephemerals (e.g. *Gyrostemon* spp.) and non-serotinous dwarf shrubs, herbs and graminoids (e.g. *Neurachne alopecuroidea*) decreased, while PFTs with persistent soil-stored seed (e.g. *Acacia gonophylla*) peaked in cover at an intermediate time since fire. Successful prediction of PFT response to time since fire in mallee was lower, suggesting different processes are driving post-fire vegetation dynamics.

Fruit production and mortality with time since fire

Key reproductive and survivorship traits in plants (vital attributes) have been widely used to define appropriate fire interval ranges for vegetation communities. Typically, minimum fire intervals are defined by the period post-fire that it takes the slowest-maturing non-resprouting species to become reproductively mature. Maximum fire intervals are defined by when component species become senescent, either through mortality or declining seed bank, but methods to measure and define longevity have been inadequately developed to date.

We used two methods to measure each of reproductive output and senescence across our chronosequence for a range of putatively fire-interval sensitive serotinous non-resprouters and serotinous resprouters (Gosper *et al*. in press). Using a range of thresholds reflecting high, medium and low levels of risk of population decline after fire, we defined minimum and maximum acceptable fire intervals for each species and integrated this into acceptable interval bounds for the mallee and mallee-heath communities.

Both communities contained multiple species vulnerable to decline under short (<25 years) fire intervals, but mallee-heath also had species taking more than 30 years post-fire to develop a substantial seed bank. Mallee-heath contained several species that experienced significant mortality (up to 90%) when long-unburnt, suggesting that these species will decline under long (>90 years) fire intervals. No species in mallee had unambiguously high mortality when long unburnt, indicating resilience to long intervals without fire.

Choice of threshold values for defining intervals had a large bearing on interval ranges, while the method of measuring trait values had little influence. In some species, variability in trait values (mainly mortality) between populations prevented the establishment of robust relationships with time since fire, and demonstrates a significant constraint in the vital attributes approach. The use of vital attributes offers a transparent approach to defining fire intervals in plant communities, but only with explicit testing of variability between populations. Further, threshold values on which intervals are based need empirical testing.

Conclusion

This research demonstrates that despite occurring in a mosaic across a fire-prone landscape, these two vegetation communities respond differently to the long-term absence of fire. Mallee-heath composition and diversity is strongly regulated by fire, with some long-term loss of biodiversity likely to result from extremely long intervals between fires. Mallee, on the other hand, shows little indication that recurrent fires are necessary for maintenance of community diversity and composition. Consistent with this, long-unburnt mallee is important for a range of fauna (see http://www.latrobe.edu.au/zoology/research/specialisations/fire-ecology/projects/mallee-fire-and-biodiversity).

Fruit of Hakea pandanicarpa*, opened after the plant was killed by fire.* H. pandanicarpa *had among the longest periods until reaching reproductive maturity, having few fruit until beyond 30 years postfire. Photo: Carl Gosper and Georg Wiehl*

This research is supporting ongoing fire management by DEC. As fires in wheatbelt remnants have been rare over recent decades, combined with the strong role of fire in regulating composition and function, it appears that prescription of fire to rejuvenate long-unburnt mallee-heath remnants is a higher priority than for mallee. However, when prescribing fire in a fragmented landscape, it is crucial that the context of the vegetation is taken into account. Nutrient enrichment directly adjoining agricultural land is likely to render regenerating native vegetation susceptible to out-competition by weeds (Gosper *et al*. 2011).

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Identifying ecosystems at risk – the new IUCN Red List

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We know quite a lot about which species around the world are most endangered. The Red List of threatened species (http://www.iucnredlist.org/), developed by the International Union for the Conservation of Nature (IUCN), identifies species that are most at risk of extinction (Rawson 2012).

But scientists have become increasingly concerned that the habitats of species and the ecological processes that influence the relationships between species are not adequately considered. Now IUCN has developed a similar risk assessment framework for ecosystems (http://www.iucnredlistofecosystems.org/about-us/red-list-ecosystems/), such as Florida's Everglades, Australia's Great Barrier Reef and Scandinavia's Boreal Forests. It lets the IUCN rank them as endangered, vulnerable or not threatened according to the risks that they face.

For the first time, we have a scientifically robust risk assessment framework, which works across the full range of terrestrial, freshwater, marine and subterranean ecosystems.

This new framework for a Red List of Ecosystems is now published in a scientific study in the Public Library of Science journal, PLoS ONE (Keith *et al.* 2013) which illustrates how it would work around the world in a trial on 20 case studies.

Together, the Red Lists for species and ecosystems will provide a more comprehensive view of the status of the environment and its biodiversity than either can on its own.

The ecosystem Red List focuses on biodiversity, habitats for species, as well as their interactions and dependencies, including food webs. The species Red List focuses on individual species, some of which may go extinct even though the ecosystems in which they live continue to remain functional.

Assessing an ecosystem

This new Red List assesses each ecosystem against five criteria.

Two of the criteria relate to an ecosystem's distribution – how rapidly it is declining and its current extent.

Another two of the criteria relate to functional characteristics of ecosystems. They measure how rapidly and how extensively the physical and biological components of an ecosystem are degrading, particularly the processes that sustain the ecosystem and its species.

The fifth criterion allows multiple threats to an ecosystem to be assessed, as well as potential synergies between them.

Among the 20 ecosystems assessed in the study, the remote mountain ecosystems of the Venezuelan Tepui are among those at least risk of collapse. These are showing little evidence of decline in distribution or function in the past or near future. At the other extreme is the Aral Sea of central Asia, which collapsed during the 1980s and 1990s.

Eight of the case studies come from Australia, and these exhibit varying levels of threat related to land clearing and its legacies, overexploitation of water resources, pollution and climate change.

The lessons from the Aral Sea assessment are sobering. Not only were a host of species lost forever as the sea became hypersaline and dried over much of its former extent, but the ecosystem collapse led to socio-economic disaster, including the closure of regional fisheries and shipping industries. Dust storms were generated from the dry sea bed and they continue to have major impacts on infant mortality and other indicators of human health.

How will this Red List help?

The Red List risk assessment methods are a vital part of the scientific infrastructure needed to support evidence-based environmental management. Other components of the infrastructure that need further development include a base of expertise for carrying out the risk assessments.

Most importantly, we need the essential long-term data needed to underpin reliable and scientifically credible assessments. Initiatives such as the Australian Government's Long Term Ecological Research Network (http://www.tern.org.au/Long-Term-Ecological-Research-Network-pg17872.html), which monitors changes in ecosystems and identifies the underlying causes of change, are a vital part of this infrastructure.

Within Australia, this new international standard for risk assessment also presents an opportunity to improve alignment among the various national and state processes currently in place for managing threatened ecosystems. It could strengthen the science and promote better co-ordination of conservation efforts across jurisdictions.

Over the coming decade, IUCN will carry out a global assessment of ecosystems, largely in collaboration with local experts and authorities.

As an early warning system, the Red List of Ecosystems will help governments, industries and communities avoid ecosystem collapse and the associated socio-economic impacts by informing better environmental decisions.

Red List assessments will better target the ecosystems most vulnerable to degradation and help determine which options for investment in environmental management will work best. Ultimately, better planning and management is needed to conserve our rich biodiversity and sustain ecosystem services that support our current standards of living.

Disclosure statement

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Report from New Zealand Plant Conservation Network

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New Zealand threat classification system

The New Zealand Threat Classification System review mentioned in our report in *Australasian Plant Conservation*, Volume 20, Number 4, March - May 2012, has been completed and is in the process of being published. The conservation status of 2581 New Zealand vascular plants were reassessed using this system. The list includes 31 more taxa than those assessed in 2008, some due to being newly described or discovered since then. The number of threatened taxa has increased from 243 in 2008 to 288 in 2012. The list shows a continuing decline of our flora. The Department of Conservation is putting out a series of publications available as PDF's on their website soon - www.doc.govt.nz.

Back from the dead?

Pittosporum obcordatum has been rediscovered on Banks Peninsula some 170 years after it was first discovered. It was thought to have been locally extinct after intensive searches by a number of botanists who could not locate it after its initial sighting. In February 2012, an ecological survey completed by Melissa Hutchison for local council on an area in Banks Peninsula uncovered this missing plant. A 'Dr. Seuss' type plant growing nearby caught her eye, so she took a photo of it and took a sample away for identification. She was able to solve the 170 year old mystery much to the delight of many. The plant with the current threat status of 'Nationally Vulnerable' is easily mistaken for *Myrsine divaricata*. There are other populations scattered in the North Island and in the southern South Island. Threats to the plants include habitat destruction, browsing animals and introduced weed species. Melissa is working on a management strategy for protecting and enhancing the existing population of *P. obcordatum* and to identify suitable sites for potential establishment of new populations on Banks Peninsula.

Network updates

A successful, 'Are we there yet? 10 years of the Plant Conservation Network' conference was held at the end of May. Although we were not quite able to answer the question of 'are we there yet?' we knew we were heading in the right direction. Presentations can be viewed on www.allaboutauckland.com search by entering NZPCN conference.

Visit www.nzpcn.org.nz for more information.

Recent workshop reports

Tricia Hogbin

Australian Network for Plant Conservation; Email: projects@anpc.asn.au

The ANPC has hosted a range of workshops over the past few months, with workshops hosted in ACT, Queensland and Western Australia. The seven workshops covered a range of topics related to the conservation, management and restoration of native vegetation.

As is typical for ANPC workshops, one of their main strengths was the diversity of presenters and participants involved. Twenty three different presenters were involved in the delivery of the seven workshops, and participants came from a diverse range of fields and backgrounds including landholders, community groups, indigenous organisations, community nurseries, universities, TAFE, and state, local and commonwealth government agencies.

Full workshop reports, including presenter details, acknowledgements, and images can be found at anpc.asn.au/courses.html.

Following is a brief summary of each workshop.

Plant identification for grassy ecosystems, Canberra ACT 13 and 14 March 2013

The sixth and final workshop in our Jewels in the Landscape series, funded through a grant from the NSW Environmental Trust, provided participants with the skills and information required to identify a range of common grassland plants.

Learning was through a combination of theory presentations, practicals and field-based activities. The in-depth look at three common families (peas, daisies and grasses) and hands-on practice keying our plants were particularly well received.

Seed collection, storage and use for native vegetation restoration, Sunshine Coast QLD 3 April 2013

This workshop provided participants with the knowledge needed to effectively collect, store and use seed in native vegetation restoration. This was the second time we've held this workshop, based on the ANPC's Plant Germplasm Conservation Guidelines, and given its success we'll continue to roll it out across Australia.

Translocation of Threatened Plants, Sunshine Coast QLD 4-5 April 2013

The Sunshine Coast Translocation workshop marked the 16th time this successful workshop has been delivered since 2004. Participants enjoyed a range of networking opportunities and left with a sound understanding of the role of translocation in the conservation of threatened plants. We managed to squeeze in six case studies presentations, the most we've ever included in a workshop.

Top: Participants of our plant identification for grassy ecosystems workshop had plenty of practice keying out plants. Bottom: Participants at our seed use for native vegetation restoration workshop learning how to test seed viability. Photos: Tricia Hogbin

Myrtle Rust - a New threat to Western Australia's biodiversity, various locations Western Australia May 2013

A series of four one-day courses on Myrtle Rust recognition, reporting, risk assessment, and management options were held in Perth, Bunbury and Albany 20 to 24 May 2013. These workshops, presented by Bob Makinson of the Royal Botanic Gardens Sydney, were well attended with over 160 participants across the four workshops.

Acknowledgements

Twenty three presenters and additional helpers assisted in the delivery of these workshops. Their assistance was invaluable and their involvement is greatly appreciated. Being too numerous to mention in this article, all presenters and supporters are acknowledged in the full workshop reports which can be found at anpc.asn.au/courses.html.

Upcoming conferences and workshops

NZPCN Conference 2013
Australian Native Plants Society 2013 Conference and Seminar

10–16 August 2013
Sunshine Coast, QLD

The Australian Native Plants Society is hosting its 2013 Conference and Seminar which will be held in late winter on Queensland's Sunshine Coast. The theme for the conference is *Diversity is in our Nature*. Associated with the Conference are several pre- and post-Conference tours. For further information visit http://asgap.org.au/whatson.html

17th NSW Biennial Weeds Conference

9-12th September 2013
Corowa, NSW

The Weeds Society of New South Wales Inc. will be holding its 17th NSW biennial weeds conference in Corowa, NSW. The theme of the conference is *Weeds have no boundaries!* For more information visit http://www.nswweedsconference2013.com/

22nd International Grasslands Congress

15 - 19 September 2013
Sydney, NSW

The overall Congress theme is revitalising grasslands to sustain our communities. The program will explore the current issues facing grasslands around the world and share the latest industry developments and solutions.

The proposed Congress program will be delivered in three main streams:

- Improving production efficiency to revitalise grasslands
- Improving grassland environment and resources
- Grassland people, rights, policies, practices and processes.

The Congress aims to present a program which is participative, innovative, stimulating, thought-provoking and enriching by offering networking and learning opportunities to new and experienced Grassland scientists, Extension workers, Postgraduate students and some undergraduate students, Agri-business professionals, policy makers and leading livestock producers and farmers from all over the world. For more information visit http://www.igc2013.com/pages/destination-sydney.php

Queensland Landcare Conference

27-29 September 2013
Warwick, Queensland

Hosted by Condamine Headwaters Landcare Group, the 2013 Queensland Landcare Conference in Warwick will bring together land managers, policy workers, extension staff and researchers to explore healthy habitats and profitable production. The Conference program will include keynote presentations, a dedicated Junior Landcare component, interactive learning opportunities, field trips, lots of networking opportunities and an exhibition for landcare suppliers and partners.

More information will also be made available online at: http://headwaters.ddrlandcare.org/index.php?option=com_contentandview=frontpageandItemid=268.

2013 Government Sustainability Conference

7-8 October, 2013
Melbourne, Vic

The 2013 Government Sustainability Conference will provide delegates from local, state and federal government authorities with comprehensive analysis and advice about how to embed environmentally sustainable policies and practices within their organisations and the communities they serve. This national conference will provide attendees with the means to network and discuss environmental best practice with officials from the nation's public sector sustainability leaders. The conference will also provide attendees with high-quality information and case studies that will assist them to address crucial environmental issues facing all levels of government.

For more information visit http://commstrat.cvent.com/events/government-sustainability-conference/event-summary-a598cde403bb4d85bd4de7bb58299793.aspx

2013 Orchid Conservation Symposium

26 -27 November 2013
Lake Fyans, Vic

In November 2013 ANOS Victoria will be hosting an Orchid Conservation Symposium at Lake Fyans in Western Victoria. This symposium will build on similar events of recent years held by the Department of Sustainability and Environment and the Royal Botanic Gardens, Melbourne.

Presentations are sought on, but not limited to, orchid taxonomy, population ecology, applied management, horticultural research, translocation, pollination strategies, and mycorrhizal associations. For further information and instructions on how to register visit http://www.anosvic.org.au/ANOS_Vic_Symposium.html.

Information resources and useful websites

Weedfutures decision support tool

http://weedfutures.net/

The recently launched weedfutures.net is an online decision support tool that provides users with the ability to search individual profiles for 292 non-native plant species naturalised within Australia and assess emerging weed threats for regions or management units of interest (Australia, state, NRM region, protected area, LGA, etc). It is intended that the web site will be gradually expanded to include all the Weeds of National Significance (WONS) species and other exotic plants of interest over the next year. The website is the result of a collaborative project between Macquarie University, University of Canberra, Department of Primary Industry (Vic and NSW) and the Office of Environment and Heritage (NSW), and was funded through the National Climate Change Adaptation Research Facility.

Wet Tropics World Heritage Area - e Bulletin

Wet Tropics Management Authority

The Wet Tropics Management Authority recently launched a Learning Landscape eBulletin that showcases current and emerging Wet Tropics research and related land management and policy issues. The e Bulletin will be of interest to anyone interested in exploring the interface between knowledge and policy, knowledge and practice, and knowledge and behaviour. For more information and to subscribe visit: http://www.wettropics.gov.au/a-learning-landscape-ebulletin.html.

Australian Policy Online

http://apo.org.au/

Policy Online is a research database and alert service providing free access to full text research reports and papers, statistics and other resources essential for public policy development and implementation in Australia and New Zealand. The site specialises in reports and articles (grey literature) on public interest issues, including the environment. Examples of recent reports shared relevant to the conservation of native vegetation include: 'Prioritising naturalised plant species for threat assessment: developing a decision tool for managers' and 'Adaptation to climate in widespread eucalypt species'. Subscribe to receive weekly updates at: http://apo.org.au/subscribe

The Conversation

http://theconversation.com

The Conversation is an independent and online source of news and views, sourced from the academic and research community and delivered direct to the public. The site regularly publishes articles relevant to the conservation and management of native vegetation in Australia. For example, recent relevant news articles include: Can we offset biodiversity losses? Identifying ecosystems at risk – the new IUCN Red List (republished in this issue on page 23), and Our national parks must be more than playgrounds or paddocks.

Bournda Online Herbarium

http://www.bournda-e.schools.nsw.edu.au/ecosystems/terrestrial/

This online digital herbarium for Bournda National Park, on the Far South coast of NSW, provides a useful local resource for students, teachers and the general public. The digitised personal herbarium of local botanist Dane Wimbush also provides an inspiring example of how digitising a local or regional herbarium can increase its appeal and use. Most specimens are accompanied by an image and links to further information. Specimens can be browsed by flowering month or genus.

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Keep up to date with the latest news about plant Conservation in Australia by subscribing to ANPC's email newsletter - ANPC News. Details of upcoming events, resources, funding opportunities, courses, and volunteering opportunities will be emailed to you every 2-4 weeks.

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The ANPC welcomes contributions to ANPC News. Email your news to anpc@anpc.asn.au with "For ANPC News" in the subject line. Please keep your news item concise (<250 words) and preferably provide a link that readers can click to for further information.

Research round up

Compiled by Kirsten Cowley, Centre for Plant Biodiversity Research, Canberra.

Email: Kirsten.Cowley @csiro.au

Auld, B. (2012). **An overview of pre-border weed risk assessment and post-border weed risk management protocols.** *Plant Protection Quarterly* 27(3): 105-111.

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Research round up (cont.)

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Contributions to Research Roundup are welcome, and should be sent to Kirsten Cowley at the above email address using an email subject heading "APC Research Roundup" or similar. Their inclusion will be subject to available space.

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ANPC gratefully acknowledges the support of the following corporate members

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Australian Network for Plant Conservation, Inc
presents a workshop on

Plant identification for flora of the Wimmera

Horsham, Victoria
30th – 31st October 2013

This two day workshop will introduce participants to the plant communities and threatened flora of the Wimmera region and provide the skills and information required to positively identify a range of common plants.

We will use some of the most commonly encountered plant groups to introduce you to the best identification resources (printed, on-line, and interactive). You will also learn how to access the experts through the identification services of the major herbaria. Along the way we will de-mystify identification 'keys', and introduce you to useful field characters to look for.

The workshop is targeted at the beginner level, but will also provide a good opportunity for those more experienced in plant identification to refresh their skills.

Learning will be through a combination of theory presentations, practicals and field-based activities

For further information, including a full program and registration details, visit the ANPC website www.anpc.asn.au and click on courses and workshops. Alternatively contact the ANPC national office on anpc@anpc.asn.au or (02) 6250 9509.

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